

A Risk Analysis for Contaminated Sportfish

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Background

Sources:

3 Superfund sites

- PCBs, Cyanide, Al, F, PAH,

Extensive residual damages

- Sportfish: walleye, yellow perch, sturgeon, bullhead, smallmouth bass

Atmospheric deposition

- $\text{Hg} \rightarrow \text{methylation} \rightarrow \text{MeHg}$

Project Goals

Null Hypothesis: Fish are contaminated (H_o)

Alternate Hypothesis: Fish are clean (H_a)

Goal 1

Minimize direct exposure (C_m)

→ Objective : Accurately describe the target

→ Objective : Accurately estimate true mean

**Acknowledge type 1 and type 2 error

→ Objective : Assess mean by species

Project Goals

Null Hypothesis: Fish are contaminated (H_o)

Alternate Hypothesis: Fish are clean (H_a)

Goal 2

Manage direct exposure (C_m)

→ Objective : “do no harm”

→ Objective : Generate advisories when appropriate

**Acknowledge countervailing risks

**Acknowledge public good

→ Objective : Effectively communicate risk to public

Error and Consequences

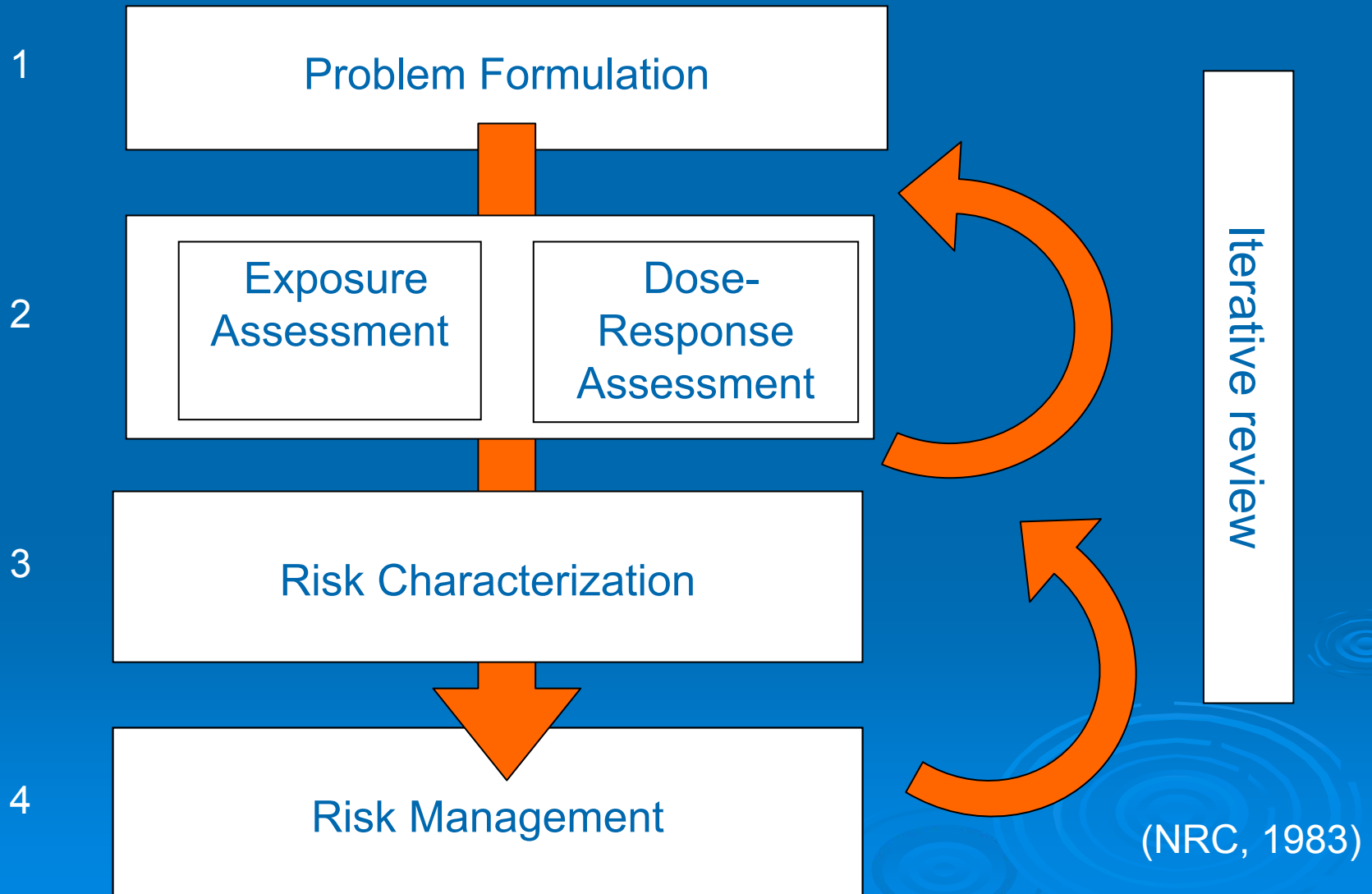
Null Hypothesis: Fish are contaminated (H_o)

Alternate Hypothesis: Fish are clean (H_a)

Type 1: (alpha) False research claim: fish are clean when they're dirty

Type 2: (beta) Fail to show fish are clean; people continue to avoid fish unnecessarily

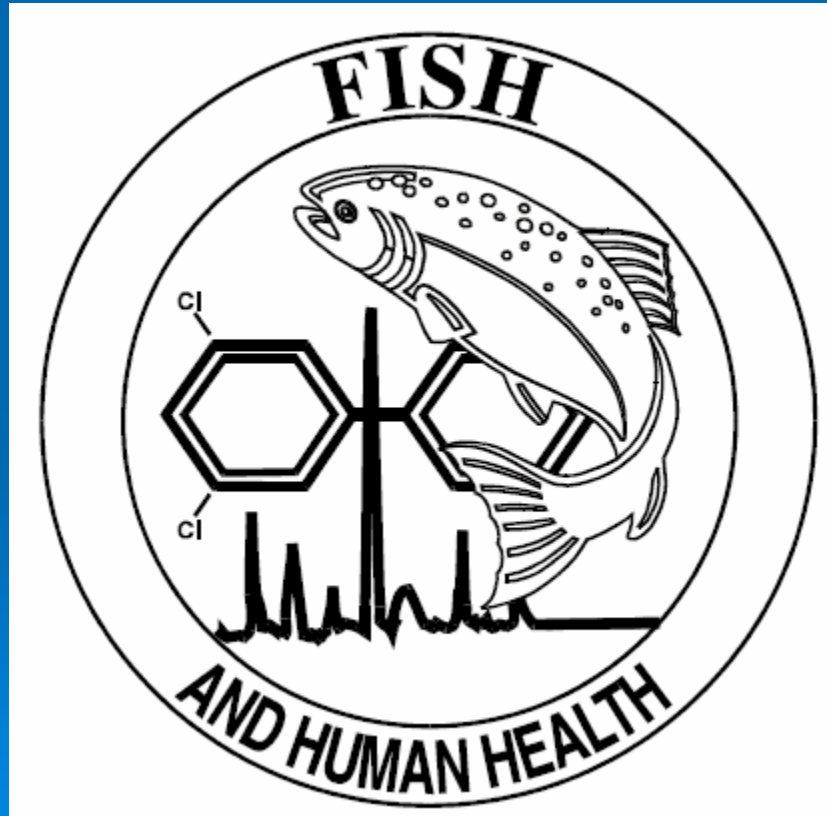
Process of Risk Analysis



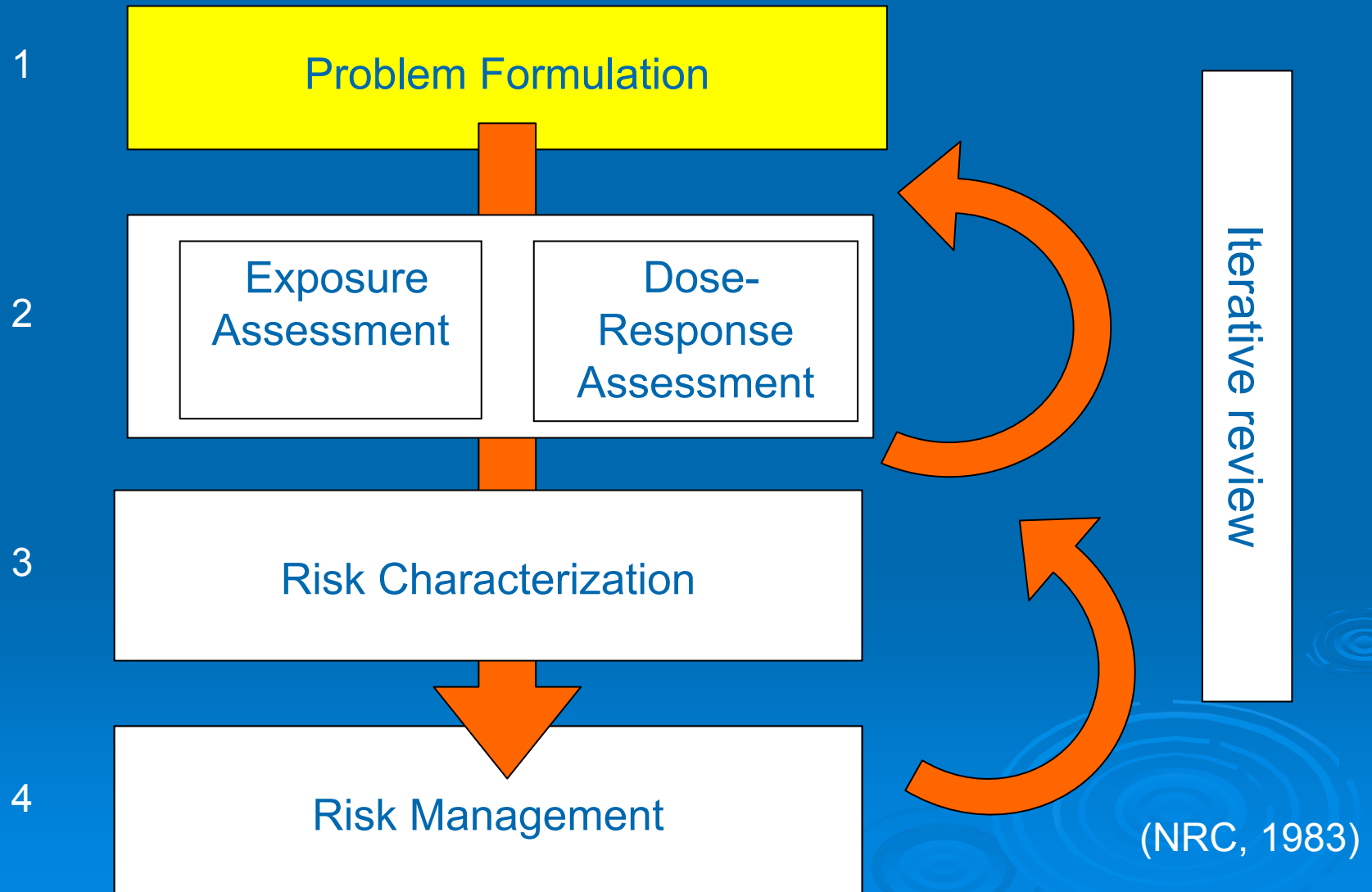
EPA Guidance

www.epa.gov/officeofwater/fishguidance

Guidance for Assessing Chemicals in Sportfish V1-4



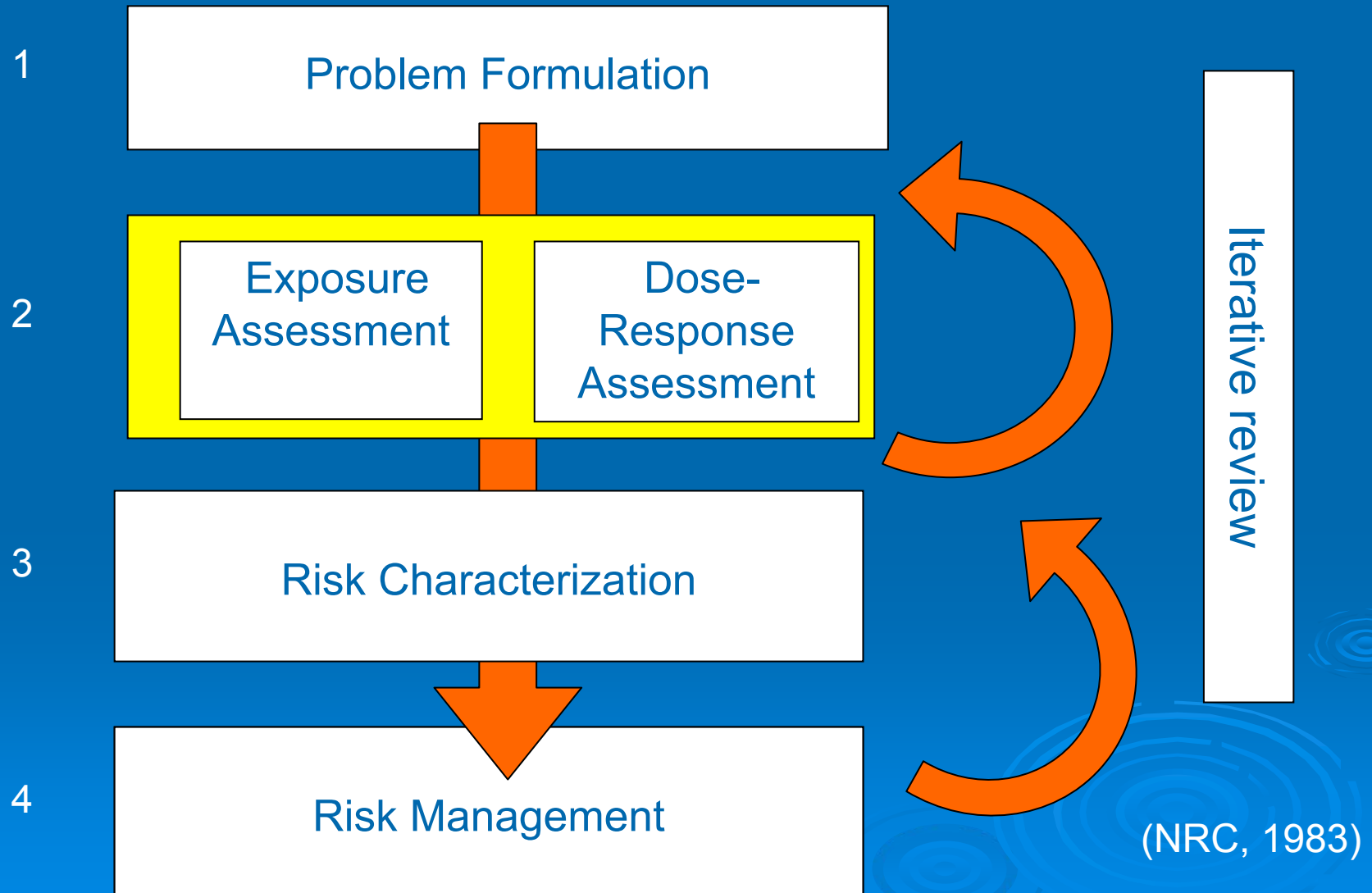
Process of Risk Analysis



Hazard Identification / Problem Formulation

➤ Parameters of concern (C_m)	PCBs, Hg
➤ Pathways	fish consumption
➤ Targets	just anglers?
➤ Potential harm	great
➤ Chemodynamics	→ concentrations variable → adult v. young of year → fatty v. lean
➤ Fate and mobility	TBD

Process of Risk Analysis



Exposure Assessment

Quantitative risk calculations

Physical Risk = Dose & Rate & Duration

Recreational angler 17.5 g/dy (NYSDEC)

- one meal / 2 weeks

Subsistence angler (Great Lakes)

- Upper bound 150 g/dy
 - three meals per week
- Central tendency 75 g/dy
 - 1.5 meals per week

Exposure Assessment

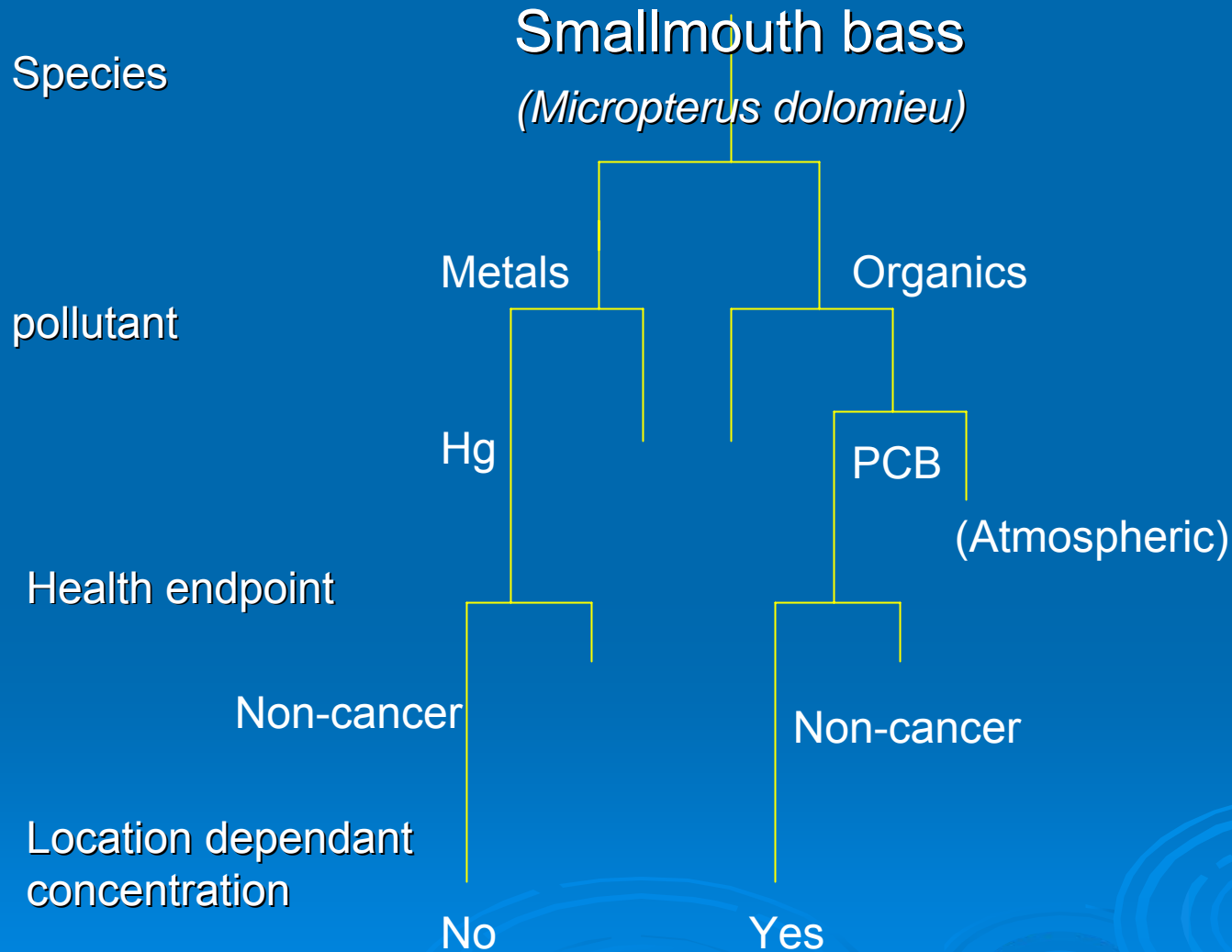
Species

pollutant

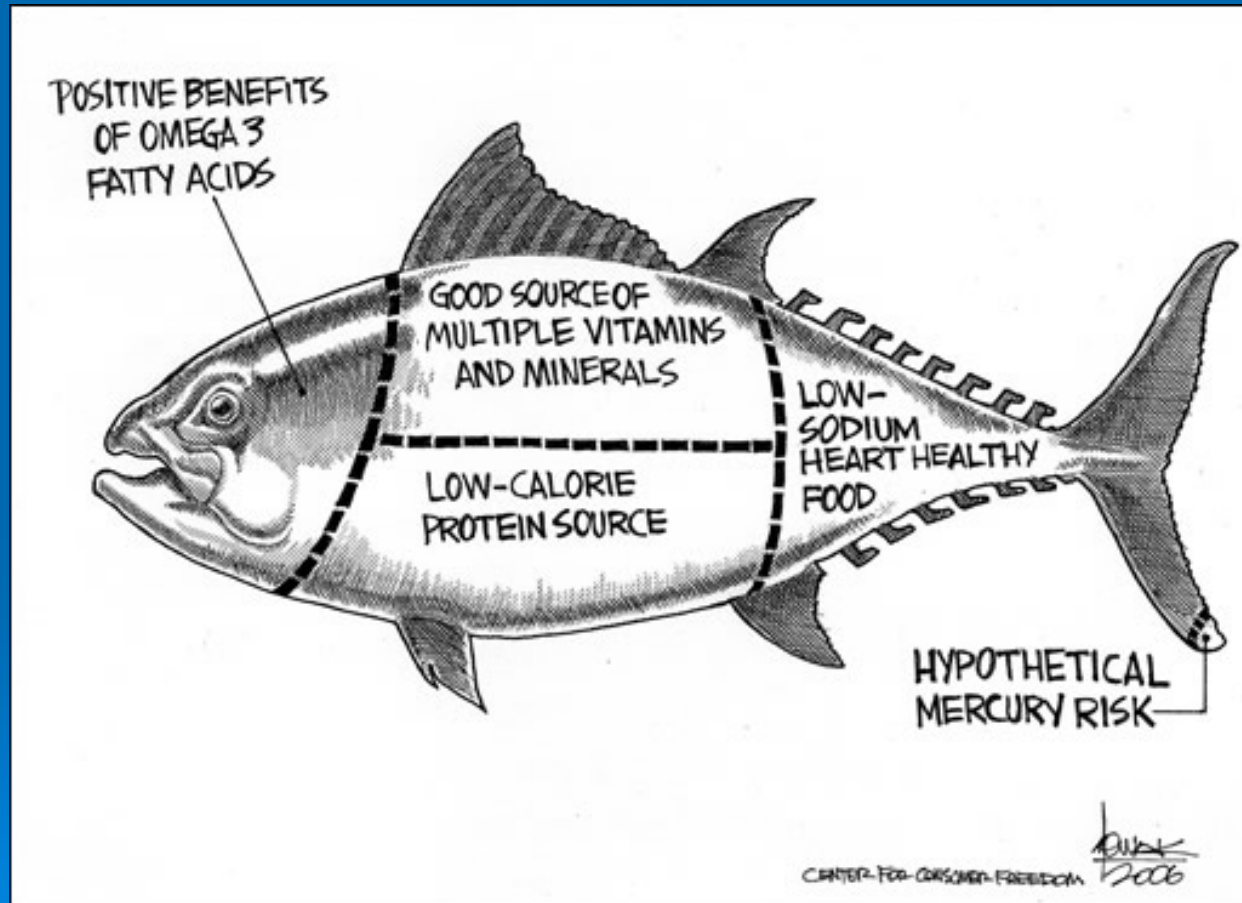
Health endpoint

Location dependant concentration

Exposure Assessment



What's safe to consume?



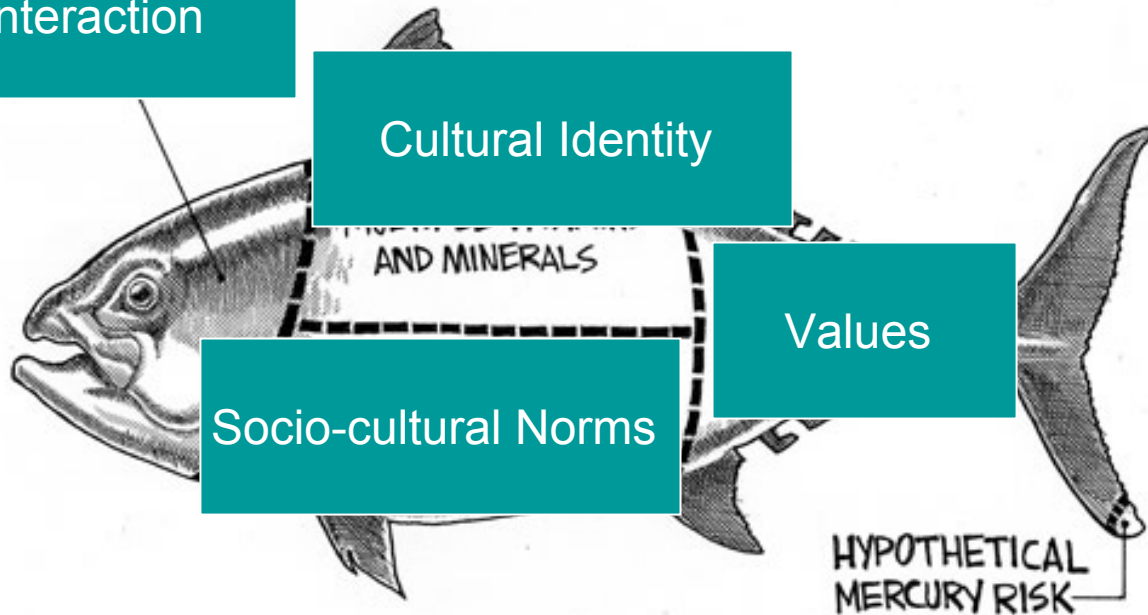
What's safe to consume?

Parent / Grandparent
Child interaction

Cultural Identity

Values

Socio-cultural Norms



CENTER FOR CONSUMER FREEDOM

2006

Cancer Risk

(Lifetime exposure)

$$\text{Acceptable \# of meals per month} = \left[\frac{\text{ARL} \times \text{BW}}{\text{CSF} \times C_m} \right] \frac{30.44 \text{ days / month}}{0.227 \text{ kg meal}}$$

Acceptable Risk Level

10^{-5}

Body Weight

70 kg

Cancer Slope Factor (EPA)

2.0 mg/kg-d⁻¹ (PCBs)

Concentration of contaminant

C_m

What's safe to consume?

Cancer Endpoints

PCBs

Allowable meals
per month

Concentration PCBs
(ppm, wet basis)

16	0-0.0029
12	>0.0029-0.0039
8	>0.0039-0.0059
4	>0.0059-0.0120
6	>0.012-0.016
2	>0.016-0.023
1	>0.023-0.047
0.5	>0.047-0.094
None	>0.094

Assumptions:
CSF (EPA)
70kg bw
10⁻⁵ risk level

Show spreadsheet

Non-Cancer Risk

- Non-cancer endpoints
- Sensitive sub-populations (women/ children)
- Uncertainty factors / modifying factors
- Is it realistic given large uncertainty?

$$\text{Acceptable \#} = \frac{\text{RfD} \times \text{BW}}{C_m} \times \frac{30.44 \text{ days / month}}{0.227 \text{ kg meal}}$$

meals

- Does this apply to men?

What is RfD anyway?

Reference Dose (RfD)

LOAEL 0.005 mg/kg-dy
exposed monkeys

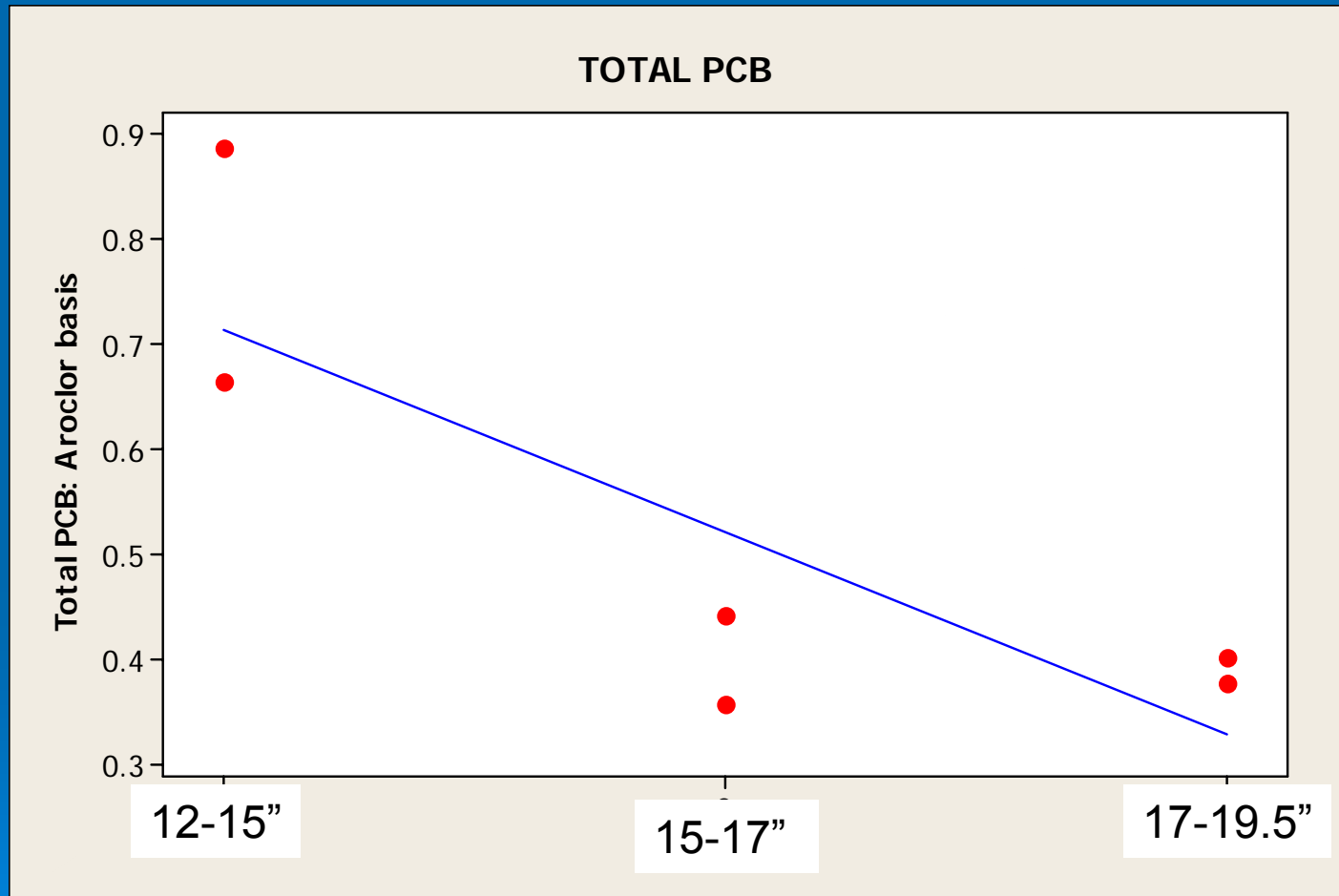
NOAEL

$$\text{PCB RfD} = \frac{\text{NOAEL}}{\text{UF \& MF}}$$

300

- sensitive individuals
- monkeys to humans
- sub-chronic to chronic
- LOAEL over NOAEL

Total PCBs: smallmouth bass



FDA Tolerance: 2.0ppm (21 CFR 109.30)

Cove Near General Motors

(Fish '04 prior to remediation)

Species	Average	Upper bound
Brown Bullhead (3)	10.1ppm	(16ppm)
Yellow Perch (3)	8.0ppm	(9.9ppm)
Northern Pike (3)	13.4ppm	(20.7ppm)

Total Hg

Size Class	Number of Fish	Number of Analysis	Average Hg (ppm)
12-15-in	7	2	0.386
15-17-in	21	2	0.447
17-19.5-in	14	2	0.830

All-Northeast Average

Range

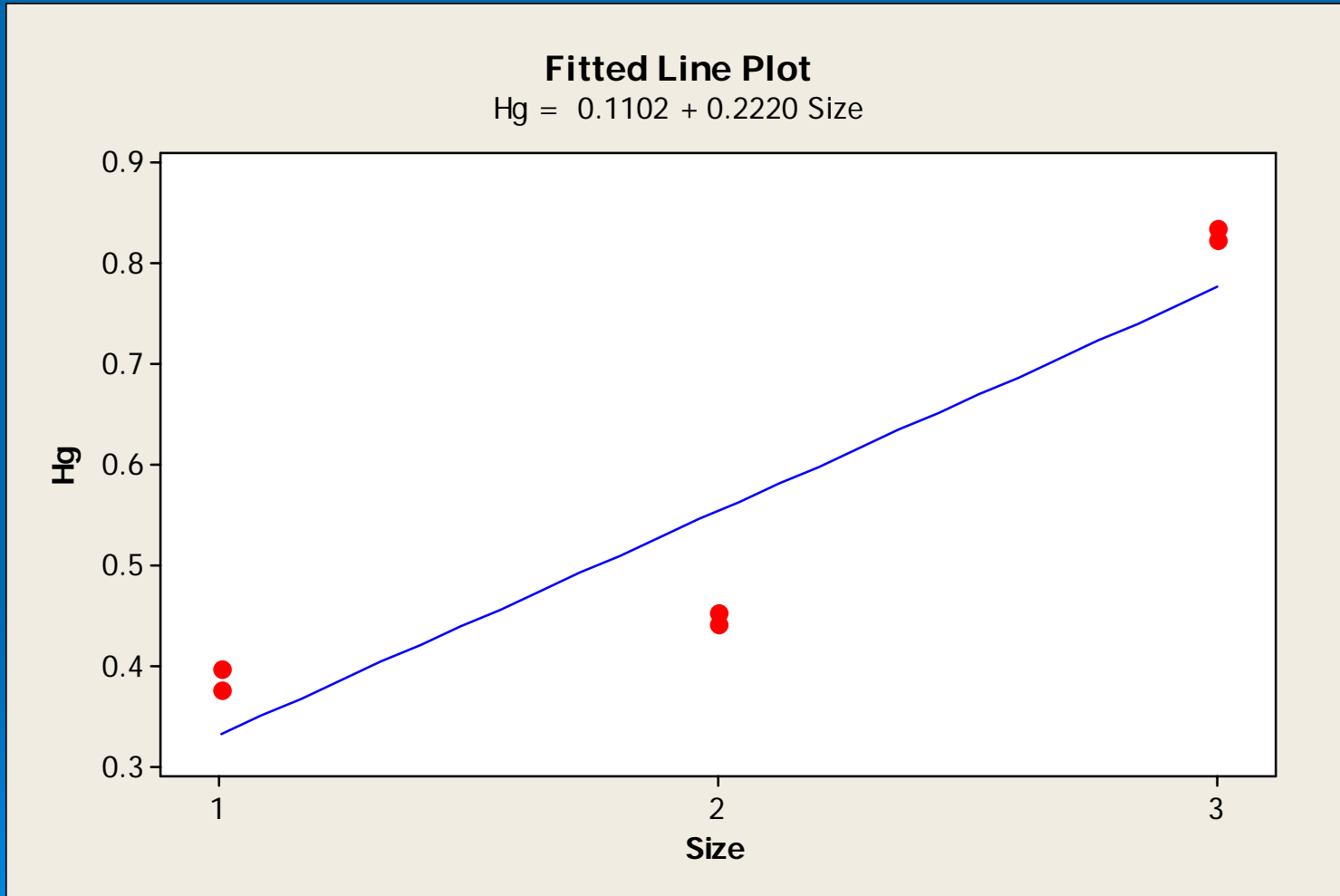
Smallmouth Bass:

0.53ppm

(0.08 – 5.0ppm)

EPA: Mercury Update: Impact on Fish Advisories
<http://epa.gov/ost/fishadvice/mercupd.pdf>

Total Hg



$R^2 = 84.5\%$
 $P = 0.009$
 $\hat{C}_m = 0.55\text{ppm}$

What's safe to consume?

Non-Cancer Health Endpoints

Hg

Allowable meals
per month

Concentration Hg
(ppm, wet basis)

Bass Length

12-15"

15-17"

17-19.5"

16	0.03–0.06
12	> 0.06–0.08
8	> 0.08–0.12
4	> 0.12–0.24
6	> 0.24–0.32
2	> 0.32–0.48
1	> 0.48–0.97
0.5	> 0.97–1.9
None	> 1.9

Assumptions:
EPA RfD
70kg bw
10⁻⁵ risk level

What's safe to consume?

Non-Cancer Health Endpoints

PCBs

Allowable meals
per month

PCB Concentration
(ppm, wet basis)

16	0.0059 – 0.012
12	>0.012 – 0.016
8	>0.016 – 0.023
4	>0.023 – 0.047
3	>0.047 – 0.063
2	>0.063 – 0.094
1	>0.094 – 0.19
0.5	>0.19 – 0.38
None (<0.5)	>0.38

Bass Length

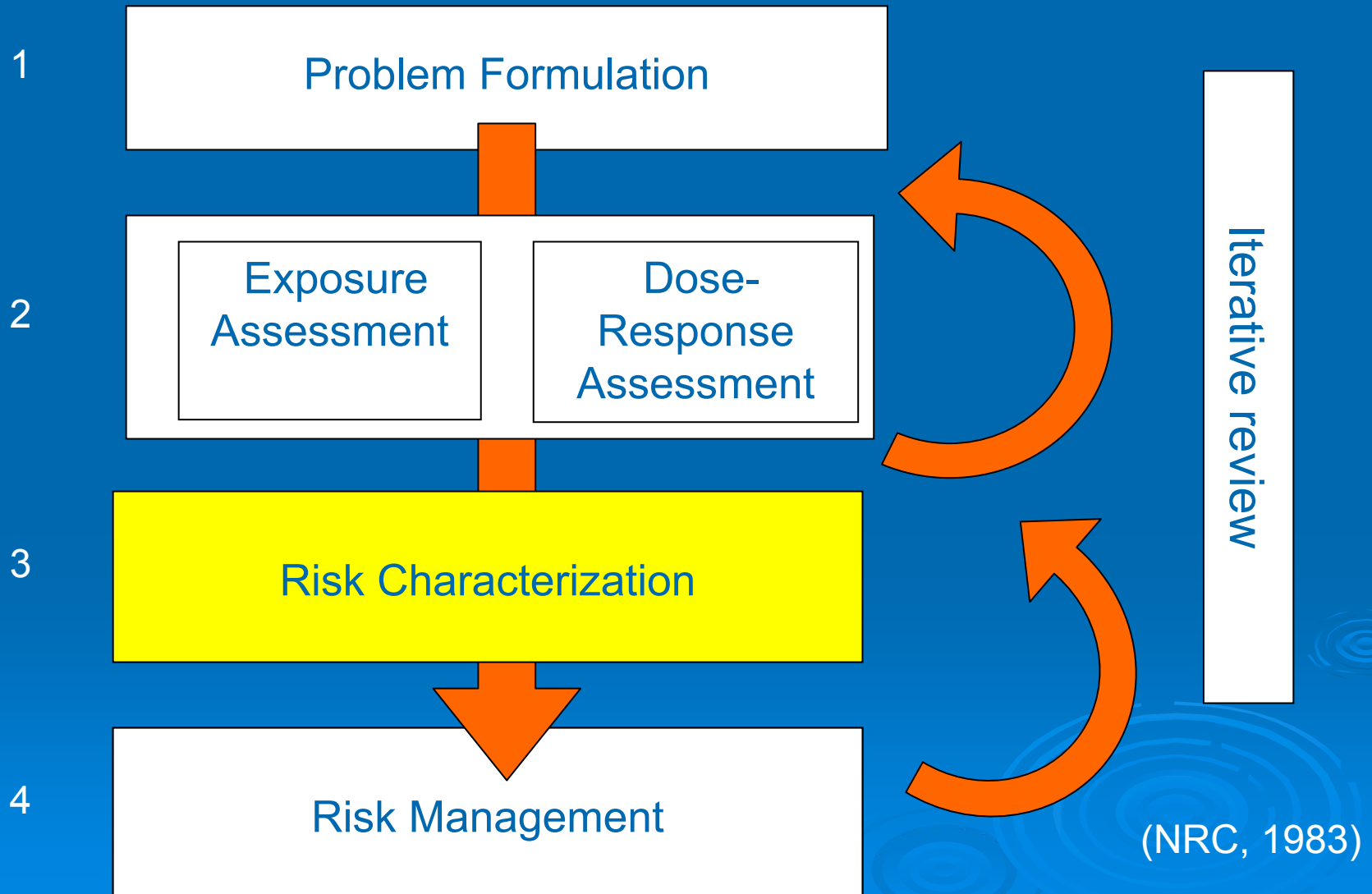
12-15"
15-17"
17-19.5"



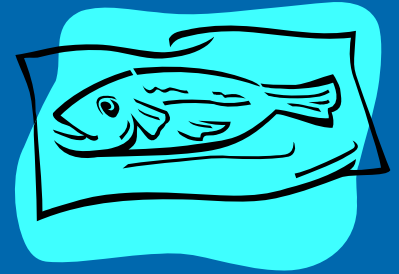
Assumptions:
EPA RfD
70kg bw
10⁻⁵ risk level

Show spreadsheet

Process of Risk Analysis



Risk Characterization



- Weight the risks
- Public health concerns
- Magnitude and breadth of potential harm
- Risk categories: youth, women, men, elderly

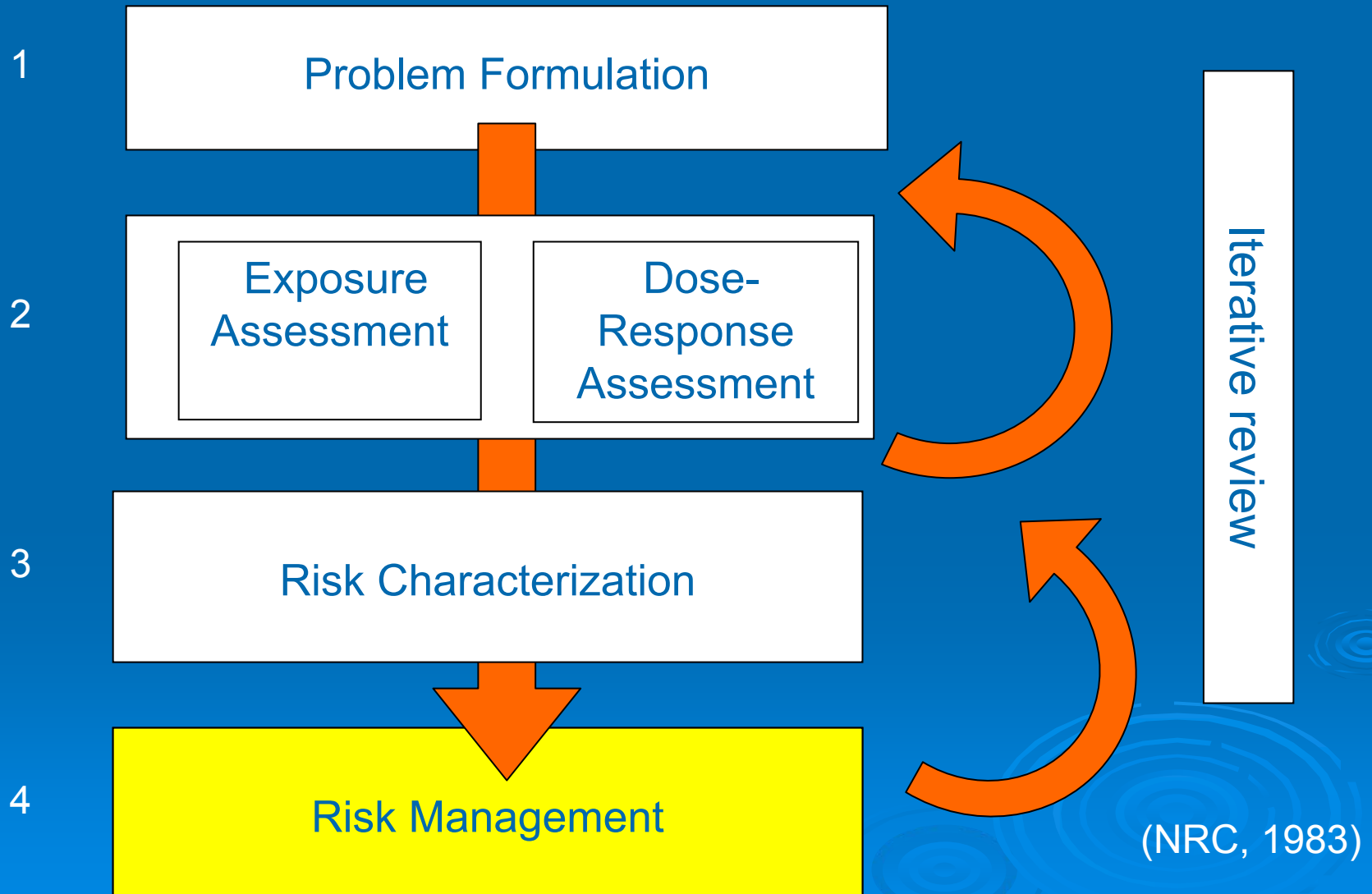


Risk Characterization

What decisions do we make about the data?

- Approach: Qualitative, quantitative, or both
- Cancer v. non-cancer endpoints
- What default values are acceptable
 - Recreational exposure (17.5 d/g) (NYSDEC)
 - Subsistence (142 g/d, EPA) (150 g/d, SRMT)

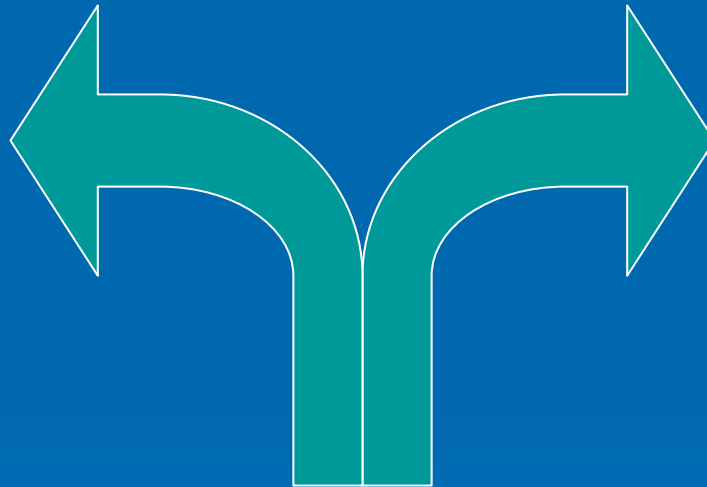
Process of Risk Analysis



Diverging Risk Categories

1. Developing children
2. Women of childbearing age

3. Men
4. Women not having children



Eat None

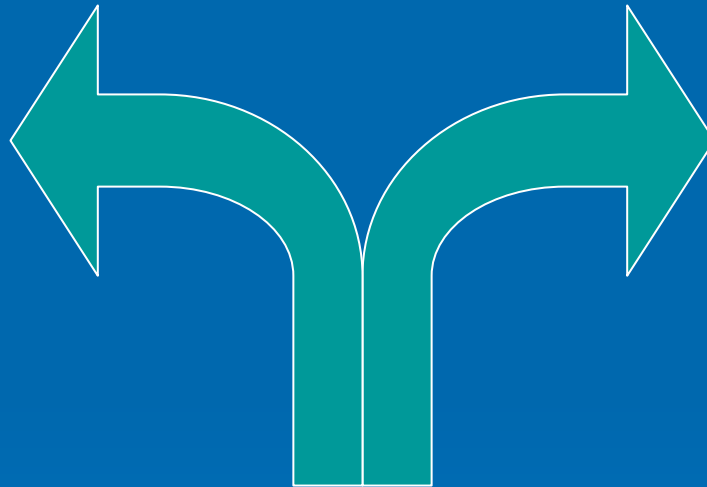
Limit Consumption

Is there an acceptable dose?

YES

Diverging Risk Categories

Direct Risk
(Physical Risk)



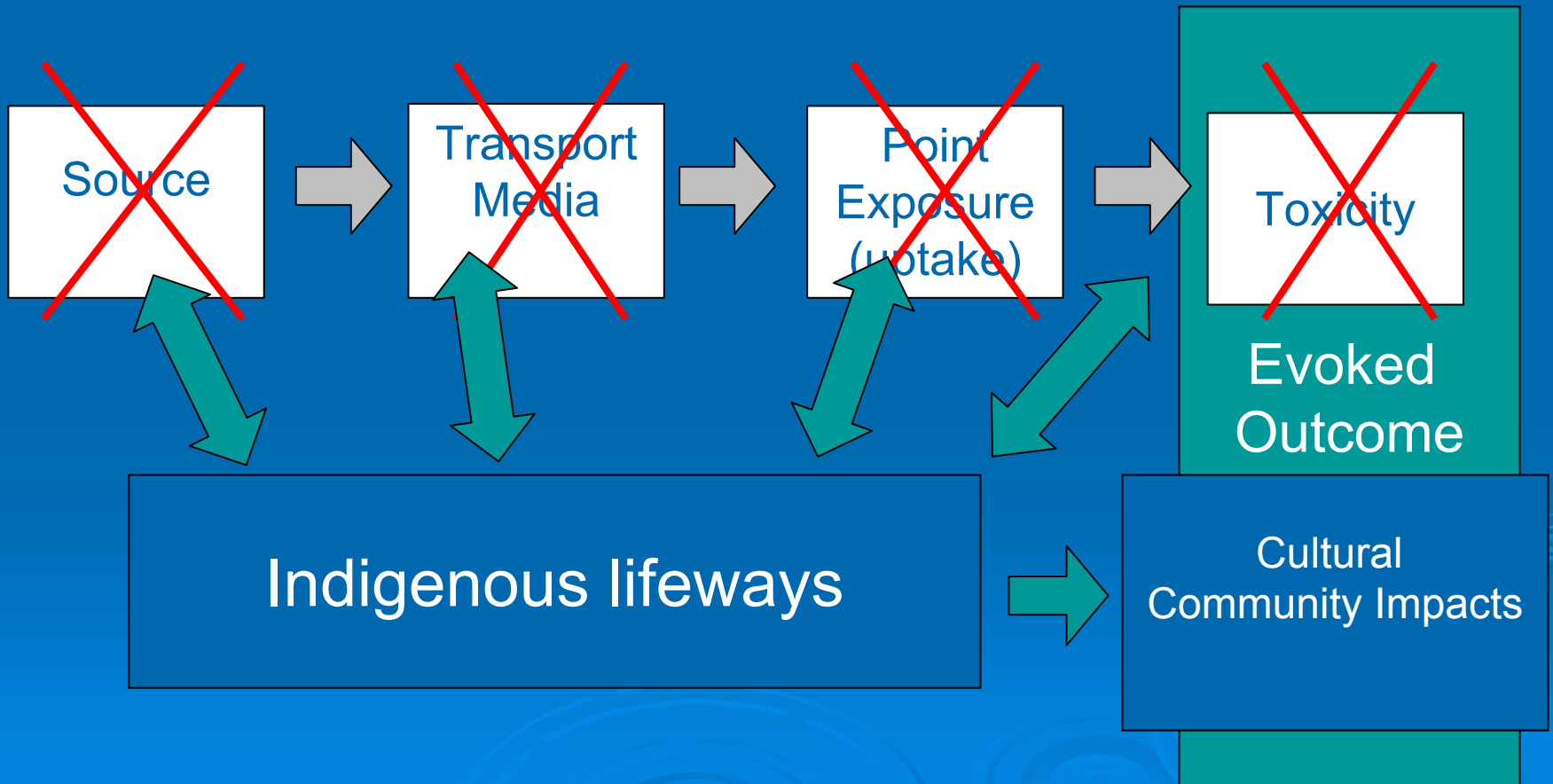
Indirect Costs
(Abstract Risks)



Conventional Risk Paradigm

Four Basic Components of Physical Risk

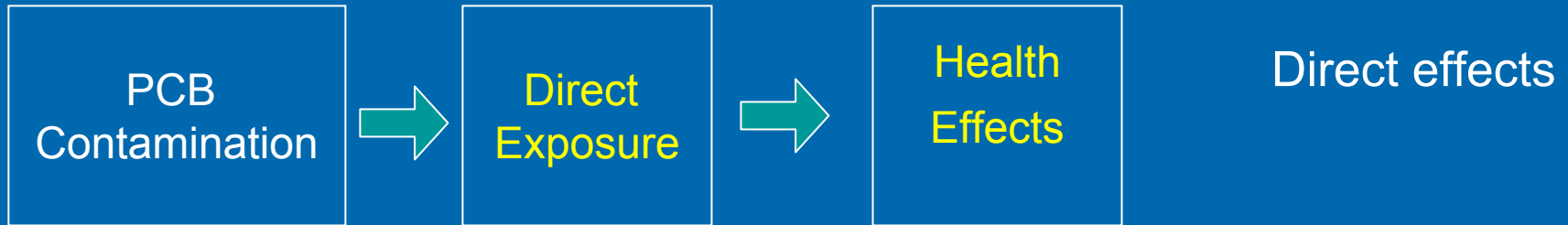
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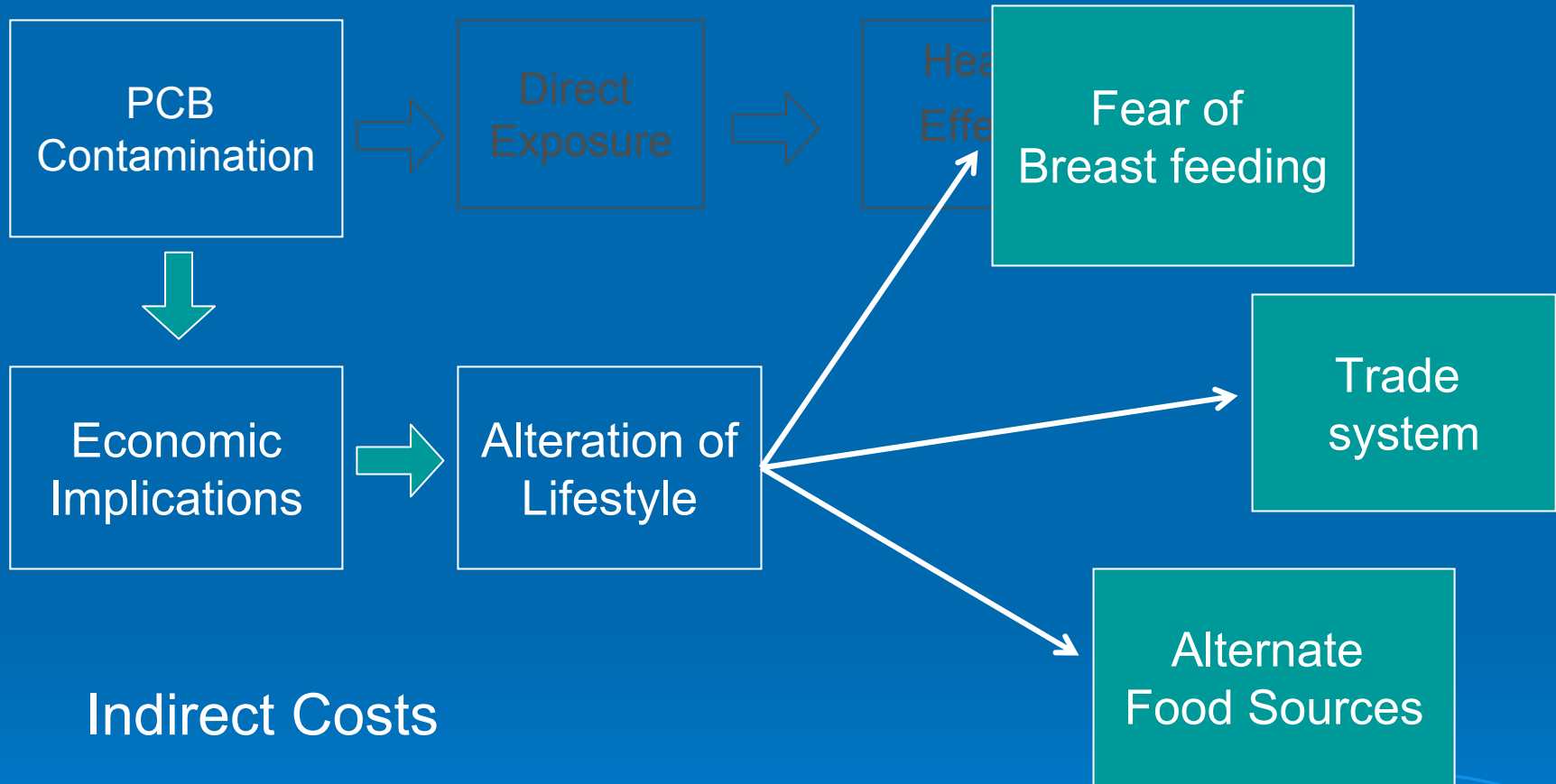
Evaluating Indigenous Lifestyles

- Cultural / religious significance of use
 - Need to eat fish
- Limited economic options
 - Reservation unemployment rates
- Nutritional Benefits of fish
 - Traditional diet
 - Omega 3 trans fatty acids
 - Brain and coronary benefits

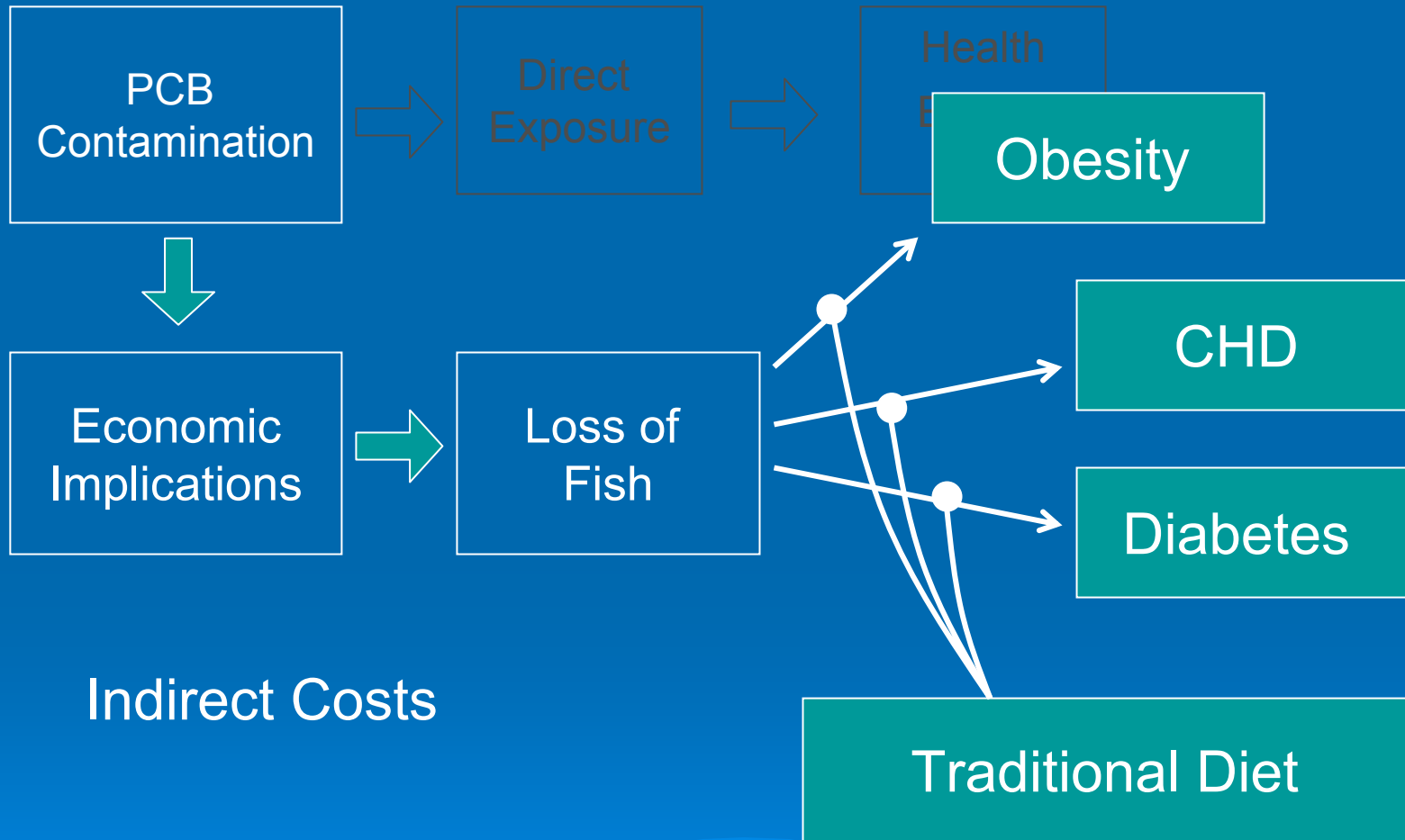
Comprehensive Risk Framework



Comprehensive Risk Framework



Comprehensive Risk Framework



What do we tell the public?



The Message

Smallmouth bass

Eat none

1. Children
2. Women of child bearing age

Limit consumption

1 meal/month

1. Women not having children
2. Men
3. Elderly

The Message

Smallmouth bass

- Measurable amounts of PCBs and MeHg
- PCBs
 - No length to concentration relationship
 - Discrete sources of PCBs remain
 - Not independent and randomly distributed
- Total Hg
 - Strong Length to concentration relationship MeHg
 - $R^2 = 84.5$, $P = 0.009$
- Hg risk < PCB risk